The Principal Courses

1. General Physics (chemical, biological, geology-geographical, ecological faculties)

Discipline of «General physics» belongs to fundamental disciplines and plays a considerable role in forming of scientific world view and professional skills of future specialists. The course consists of subsections: Mechanics; Molecular physics and thermodynamics; Electricity and magnetism; Optics; The elements of nuclear physics and quantum mechanics. A course provides for four forms of employments of students: lecture, which take place in the specialized audience, equipped modern educational hardwares; laboratory employments during which students carry out the laboratory practical work, meet with the methods of the physical measurings, treatment of results, estimate of errors; practical employments during which students acquire skills of decision of physical tasks; independent work of students, which includes working of educational material and implementation of individual tasks.

2. Contemporary problems of the magnetics physics - *choice of faculty*

The syllabus is intended to acquaint students with the experimental results that served as a basis for the contemporary understanding of the nature of magnetic phenomena in condensed matter. The modern views on the nature of microscopic carriers of magnetism and the machinery of their interaction in metals and dielectrics – the mechanisms which are responsible for the creation of different magnetic states in a substance - are explained. Attention is paid to topical directions of magnetism – frustrated magnets, nanoparticles, giant magnetoresistance materials and spintronics.

3. Computer Modeling of Physical Processes and Phenomena

The scope of the course is to let students apply their knowledge of Physics and Mathematics obtained at their bachelor studies while modeling real physical processes by modern methods and software. Educational, experimental and theoretical research aspects are lectured and practiced, as well as modeling in applied research, engineering, and related fields of science and science education. Students acquire experience of practicing modeling in *LabView*, *Coach* and other advanced software, master the technique of animation in *Excel* (using correspondent macros).

4. The special courses

Teaching program for bachelors

Theoretical teaching of bachelors

1. Magnetic properties of atom and weak magnetism

The Program proposes informing the students with key scientific facts and classical experiments, which define the modern conceptions about nature of magnetic phenomena, which occur in physical objects of the different scales - from elementary particles to cosmic objects of Universe. In teaching process, a special attention is given to elucidation of electric nature of magnetic phenomena, magnetic properties of electron, proton and neutron, relationship between their mechanical and magnetic moments. The special accent is made on a quantum nature of magnetism, quantization of projections of kinetic momentum, and magnetic moment.

In studies of magnetic properties of electron shell of the atom the attention is focused on a part of Coulomb interactions related with the electron properties defined by Pauli principle, as well as on relativistic interaction of spin and orbital magnetic moments, and on the role of these interactions in forming the resulting magnetic moments of atoms, ions and molecules.

In studies of the weak magnetism (the para- and diamagnetism of dielectrics and normal metals), the properties of real paramagnetics are compared to the properties of the ideal models. Studies of diamagnetic properties of the atoms and molecules are provided also.

2. Magnetic-ordered substances

Studying the cooperative magnetism in ordered magnetics includes: getting informed about the main types of interactions responsible for the rise of magnetic ordering; gaining insight into the main types of the magnetic structures, forming in real crystals; comprehension of magnetic phase transitions; the studies of non-magnetic physical phenomena, accompanying the processes of the magnetic ordering, rearrangement of magnetic structure and magnetization; informing about the experimental methods of determination of symmetry of magnetic structures and methods of producing, measurements and usage of magnetic field.

The questions of the practical application of magnetic materials and advances in modern technology based on them are considered.

3. Theory of processes of magnetizing

On the basis of the knowledge received at studying of «General physics» course, students study the basic interactions responsible for a magnetic condition; the physical mechanisms causing occurrence of domain structures and transitive layers between domains, processes of evolution of magnetic structures in external magnetic fields at magnetization of magnetics; the basic physical principles, which use gives the chance to create magnetosoft and magnetohard materials.

4. Phase transitions in magnets

The following principal questions are considered in the course. Concept of phase. Symmetry role. internal and external parameters. Phase transition and ordef parameters. Type of transition. Critical phenomena. System dimensionality and long-distance order. The main principles of phenomenological phase transitions theories. Symmetry approach. Landau theory. Haisenberg, Ising, and XY models. Types of magnetic phase transitions. Temperature transitions and field transitions. Anisotropy role. Peculiarities of magnetic phase transitions in amorphous and disordered systems.

5. Methods of the magnetic measurings

The course acquaints with the main experimental methods of the properties research of the magnetic-ordered matters various classes, with the methods of receipt of information on fundamental interactions and phenomena which form the matter magnetic state.

6. Spectroscopy of Magnetics

The course objective is to acquaint students with modern optical spectroscopy of solids and, in particular, spectra of magnetic ions in crystals. The course covers main principles of formation of magnet-concentrated crystal spectra and their characteristics. Elements of the group theory and its application for the analysis of spectra are discussed. Spectra of absorption, luminescence and combinational dispersion of light, as well as received on the basis of their analysis information on mechanisms of interactions in crystals are considered. The course precedes a special laboratory course, in which students get acquainted with relevant experimental research.

7. Bases of magnetic resonance

Short annotation of discipline and modules: Purpose of course - to acquaint students with the basic concepts of magnetic resonance and connection of the resonance phenomena with base presentations of physics of magnetism, with methods of theory and eksperiment in magnetoresonance investigations, with using of magnetic resonance methods in scientific researches and technique. A course consists of two modules:

a) magnetic resonance in the magnetically diluted state (motion equation for magnetic moment,
b) Bloh equations, theory of the crystalline field, method of equivalent operators, effective spin-gamiltonian, technique of resonance experiment) - 25 lecture hours;
c) b) magnetic resonance in magnetically ordered state (exchange interaction, spin-spin and spin-lattice relaxation, Van-Vlek's method of moments, effective field, Landau-Lifshitz equation, dynamic susceptibility, FMR and AFMR) - 20 lecture hours.

8. Methods of researches of properties of solids

The course objective is to acquaint students with the traditional methods used for conducting research of solids properties and characteristics, which are used in modern physics of the condensed state. The basic experimental methods of measuring are consistently considered, beginning from determination of structural parameters of crystal grate and concluding with optical descriptions. Special attention is paid to the necessity of comprehensive research and complementary information, obtained on the basis of different methods. A course serves as an overview and allows students, specialized in area of magnetism, to have a broader view on research of solids.

Experimental teaching of bachelors

1. The use of the personal computer is in scientific researches

Purpose of course - to give to the students the base ideas about modern methods of the computers in application the scientific researches. Basic form of the employments is carrying out realization by the students of practical tasks on a computer.

Students meet with the general chart of the computer device, classification of the operating systems, management by computer work, on the example of the Windows and DOS operating systems. Data visualization is examined in detail on the example of graphic package of Origin. As an instrument for the carrying out of measurings, management by devices, gathering and their analysis the graphic programming environment of LABVIEW is studied.

Laboratory practical work

1. Bases of X-ray analysis and modern crystallography

Students meet with the fundamental concepts of modern crystallography and X-ray structure analysis, basic problems and directions of researches of magnetic-ordered matters.

Students execute the followings laboratory works:

- Bases of x-ray technique.
- Debye method research of metals in the polycryctalline state.
- Precision methods of the metals researches.
- X-ray structure analysis of texture;
- Quantitative and high-quality phase analysis of two-component alloys.
- A Laue method of the monocrystals research.

At conceptual-analytical level influence of features of crystalline structure on the dynamics of processes which take a place in magnetic-ordered mono- and polycryctal is demonstrated.

2. Physical properties of the magneto-ordered matters and their investigation methods

Aims and tasks of study of discipline: acquaintance with the main experimental methods of the magnetic-ordered matters properties research. Practical work consists of such modules:

- Receipt and research of the magnetic fields
- Research of magnetizing processes and alternating magnetizing of ferromagnetics
- Research of magnetic phase transitions
- Computer design of experimental tasks of practical work.

3. The resonance phenomena in magnets

At the laboratory practice laboratory works are performed on next themes:

- Frequency dependence of ferrimagnetics initial permeability
- Ferromagnetic resonance (FMR) in magnetoisotropic magnetics
- FMR in magnetoanisotropic magnetics
- he influence of uniaxial elastic pressure on FMR.
- Nuclear magnetic resonance (NMR) in liquids.
- Research of NMR of 57Fe nucleus in domain borders of BaFe12O19 hexaferrite.
- Research of NMR of 57Fe nucleus in Y3Fe5O12 by spin-echo method.
- ?Research of temperature dependence of local fields on 57Fe nucleus by NMR in BaFe12O19.

Teaching program for master's degree

Theoretical teaching for master's degrees

1. Spin waves

On the basis of the knowledge received at studying of courses of the general and theoretical physics, students study the basic representations of the theory of spin waves within the limits of microscopic, semiclassical and quantum approaches. In the course the role of spin-wave processes is examined at the description of thermodynamic characteristics of magneto-ordered condensed bodies, the examples of the theory of spin waves use for interpretation of experimental results of low temperatures researches of magnetic properties multisublattice magnetics are considered.

2. Quantum Effects in Solids

The course is aimed at the generalization of the students' knowledge obtained due to their taking courses of Theoretical Physics, general courses of Condensed Matter Physics, and of the optional special courses, with an emphasis on the solid state effects of the quantum-mechanical nature.

3. Magnetism of the low-dimensional systems and nanosized materials

Purpose of study of discipline - to acquaint with the fundamental concepts of physics of magnetic materials with the limited spatial and spin dimension, with the modern state of problems in this branch, with methods of theoretical and experimental researches of low-dimensional and nanosized materials, with practical application of these materials.

A course consists of two modules:

a) Static and dynamic properties of the low-dimensional systems (Spatial anisotropy of exchange interactions. Mermin-Vagner theorem. Spin correlation functions, their spatial and temporal properties. Skaling and spin crossover. Dynamic properties of the low-dimensional systems, Kubo-Tomita approach, diffusive spin dynamics)

b) Magnetic nanolayers and nanopowder materials (Films and multi-layered systems. Effect of giant magnitoresistance. Spin polarization of a transport current, spintroniks. Interlayer diffusion. State of interface, his roughness. Magnetic anisotropy, its constituents. Determination of parameters of exchange and anisotropy. Powder-like magnetic nanomaterials. Superparamagnetic state, his properties. Methods of measuring of properties of nanosized magnetic powder-like materials. Superdense magnetic recording of information, principles of construction of devices for him).

4. Magnetic nanolayers and superlattices

Purpose of study of discipline - to form modern physical thought and broad scientific mind for students. To give basic concepts about the features of nanosizes objects. Technological methods are examined receipts of nanostructures and methods of their experimental research. The special attention is spared to magnetic properties of ultrathin tapes, giant magnetoresistance in magnetic superlattices and sandwiches.

5. Magnetic nano- and microcrystalline materials

The current status of research of nano-and microcrystalline ferrite powders. Introduce certification parameters. Consider methods of preparation, experimental methods, examples of practical use. We discuss the theoretical models, approaches, the basic mechanisms of the specific magnetic properties of particles and their ensembles, due to the dimensional, surface and collective effects.

Experimental teaching

Laboratory practical work

1. Modern methods of the experimental studies of magnetics *(laboratory practical work on the base of branch of department in the Institute for low temperatures of NAS of Ukraine)*

Program is provided performing the following practical work:

- Spectral magnetooptic effects in magnetics.
- Faraday Effect in paramagnetic and ferrimagnetic garnets.
- Mandelstam-Brillouin light scattering as a method of investigations of the spectra of elementary excitations in the condensed matter.
- The studies of magnetic field induced structural phase transitions by method of the long-wave infrared (IR) spectroscopy.
- Investigations of magnetic-ordered crystals properties in the paramagnetic temperature interval by means of electron paramagnetic resonance (EPR).
- Measurements of a magnetization using magnetometer with vibrating sample.
- A spin-flop of in uniaxial antiferromagnetic in the pulse magnetic field.
- Investigation of elastic and magnetic properties of a material by acoustic methods.

2. Obtaining and study the properties of nano-and microcrystalline powdered ferrite materials

Program is provided performing the following practical work:

- Getting experimental samples of nano-and microcrystalline powders of oxide ferrimagnetcs.
- Evaluation of experimental designs in terms of confirming modelnist of small particles.
- Investigation of magnetic states of nanocrystals with volumes close to critical.
- Defining the parameters of magnetic interactions in particle systems with different dispersion of particles using a standard magnetometrycal method.
- Coercetive field of high-dispersive ferrite powders and the factors that are responsible for it.